RISK ASSESSMENT

4/15/91 - 6/18/91

FAX TRANSMISSION

To	Name: Tony Walbot		
	Organization: USEPA: Office of Radiation		
	Mail Stop: ANR-461		
	FAX No.:	Area Code 8	Number 382-6918
	Verification No.:	Area Code	Number
From	Name: Bill Weis U.S. Environmental Protection Region 9, Field Operations 75 Hawthorne Street San Francisco, California 94105		
	Division / Branch (mail stop): EPA - ERS		
	Phone No.:	Area Code 415	Number 744-2297
	Phax No.:	Area Code 415	Number 744 - 1916 FTS 484 - 1916
Pages	(Including cover) 12		
Subject			
Note	Dr Rajen sent this to me. The information was generated by a computer model that provides a risk assessment for homes near a mine. I suggest you call him for the particulars as I intend to do also		

40 CFR Part 61
National Emission Standards
for Hazardous Air Pollutants

CLEAN AIR ACT COMPLIANCE REPORT
(Version 3.0 November 1989)

Facility: BLUEWATER URANIUM MINES
Address: HAYSTACK MOUNTAIN
NAVAJO NATION , NM. 87323
Annual Assessment for Year: 91
Date Submitted: 4/15/91

Comments: AIR PATHWAY RISK ASSESSMENT FOR THE VANDEVER MINES

Prepared By:

Name: Dr. Gaurav Rajen
Title: Hydrologist
Phone #: (602) 871-6861

Prepared for:
U.S. Environmental Protection Agency
Office of Radiation Programs
Washington, D.C. 20460

CLEAN AIR ACT COMPLIANCE REPORT   4/15/91   3:49 PM

Facility: BLUEWATER URANIUM MINES
Address: HAYSTACK MOUNTAIN   City: NAVAJO NATION   State: NM
Comments: AIR PATHWAY RISK ASSESSMENT FOR THE VANDEVER MINES
Year: 91

	Dose Equivalent Rates to Nearby Individuals (mrem/year)
Effective Dose Equivalent	23000.0
Highest Organ Dose is to LUNGS	150000.0

EMISSION INFORMATION

Radionuclide	Class	Amad	Area #1 (Ci/y)
U-234	Y	1.0	2.0E+00
U-235	Y	1.0	4.0E-01
U-238	Y	1.0	2.0E+00
TH-230	Y	1.0	1.0E+00
RA-226	W	1.0	2.0E+00
PB-210	D	1.0	0.0E-01
Total Area (m**2)			1.0E+02

SITE INFORMATION

Wind Data	GR_NM.WND	Temperature (C)	20
Food Source	LOCAL	Rainfall (cm/y)	40
Distance to Individuals (m)	300	Lid Height (m)	1000

*NOTE: The results of this computer model are dose estimates. They are only to be used for the purpose of determining compliance and reporting per 40 CFR 61.93 and 40 CFR 61.94.

ORGAN DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL

ORGAN	DOSE EQUIVALENT RATE TO THE ORGAN (mrem/y)
GONADS	2.8E+02
BREAST	2.9E+02
RED MARROW	8.9E+03
LUNGS	1.5E+05
THYROID	2.7E+02
ENDOSTEUM	1.1E+05
REMAINDER	1.7E+03
EFFECTIVE	2.3E+04

4/15/91 3:49 PM

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL
BY PATHWAY FOR ALL RADIONUCLIDES

	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE LUNGS (mrem/y)
INGESTION	1.7E+03	1.8E+02
INHALATION	2.2E+04	1.5E+05
AIR IMMERSION	1.2E-03	1.0E-03
GROUND SURFACE	3.5E+01	2.8E+01
TOTAL:	2.3E+04	1.5E+05

BLUEWATER URANIUM MINES

DOSE TO THE MAXIMALLY EXPOSED INDIVIDUAL BY RADIONUCLIDE FOR ALL PATHWAYS

RADIONUCLIDE	EFFECTIVE DOSE EQUIVALENT (mrem/y)	DOSE EQUIVALENT TO THE ORGAN WITH THE HIGHEST DOSE LUNGS (mrem/y)
U-234	7.5E+03	5.8E+04
U-235	1.4E+03	1.1E+04
U-238	6.7E+03	5.2E+04
TH-230	6.8E+03	2.9E+04
RA-226	1.1E+03	3.4E+03
PB-210	2.1E-28	1.9E-29
TOTAL :	2.3E+04	1.5E+05

4/15/91 3:49 PM

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF DISTANCE IN THE DIRECTIONS OF THE MAXIMALLY EXPOSED INDIVIDUAL FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTION : SOUTHEAST

DISTANCE (meters)	EFFECTIVE DOSE EQUIVALENT (mrem/y)
300	2.3E+04
1000	2.2E+03
3000	3.2E+02
10000	4.6E+01
80000	1.1E+00

EFFECTIVE DOSE EQUIVALENT AS A FUNCTION OF ALL DISTANCES AND ALL DIRECTIONS FOR ALL RADIONUCLIDES AND ALL PATHWAYS

DIRECTIONS: DISTANCE (METERS):	N	NNE	NE	ENE	E	ESE	SE	SSE
300	3.8E+03	2.1E+03	3.1E+03	4.1E+03	6.9E+03	1.6E+04	2.3E+04	1.3E+04
1000	3.5E+02	2.0E+02	3.0E+02	3.9E+02	6.5E+02	1.5E+03	2.2E+03	1.2E+03
3000	5.1E+01	2.9E+01	4.3E+01	5.8E+01	9.4E+01	2.2E+02	3.2E+02	1.8E+02
10000	7.1E+00	4.2E+00	6.1E+00	8.6E+00	1.4E+01	3.3E+01	4.6E+01	2.6E+01
80000	1.5E-01	1.1E-01	1.6E-01	2.7E-01	3.4E-01	9.2E-01	1.1E+00	7.1E-01

DISTANCE (METERS):	S	SSW	SW	WSW	W	WNW	NW	NNW
300	6.9E+03	1.2E+03	1.2E+03	3.5E+02	1.0E+03	6.7E+03	9.5E+03	4.9E+03
1000	6.4E+02	1.1E+02	1.1E+02	3.3E+01	9.3E+01	6.4E+02	9.0E+02	4.6E+02
3000	9.1E+01	1.6E+01	1.5E+01	4.8E+00	1.3E+01	9.3E+01	1.3E+02	6.7E+01
10000	1.3E+01	2.2E+00	2.1E+00	6.8E-01	1.8E+00	1.3E+01	1.8E+01	9.7E+00
80000	3.0E-01	4.7E-02	4.8E-02	1.4E-02	5.2E-02	3.6E-01	5.1E-01	2.4E-01

METEOROLOGICAL AND PLANT INFORMATION SUPPLIED TO PROGRAM----

AVERAGE VERTICAL TEMPERATURE GRADIENT OF THE AIR (DEG K/METER)

IN STABILITY CLASS E	0.0728
IN STABILITY CLASS F	0.1090
IN STABILITY CLASS G	0.1455

PLUME DEPLETION AND DEPOSITION PARAMETERS

NUCLIDE	GRAVITATIONAL FALL VELOCITY (METERS/SEC)	DEPOSITION VELOCITY (METERS/SEC)	SCAVENGING COEFFICIENT (1/SEC)	EFFECTIVE DECAY CONSTANT IN PLUME (PER DAY)
U-234	0.000	0.00180	0.400E-05	0.000E+00
U-235	0.000	0.00180	0.400E-05	0.000E+00
U-238	0.000	0.00180	0.400E-05	0.000E+00
TH-230	0.000	0.00180	0.400E-05	0.000E+00
RA-226	0.000	0.00180	0.400E-05	0.000E+00
PB-210	0.000	0.00180	0.400E-05	0.000E+00

FREQUENCY OF ATMOSPHERIC STABILITY CLASSES FOR EACH DIRECTION

SECTOR	FRACTION OF TIME IN EACH STABILITY CLASS						
	A	B	C	D	E	F	G
N	0.0277	0.0653	0.1118	0.2731	0.1517	0.3705	0.0000
NNW	0.0169	0.0555	0.0852	0.3901	0.1569	0.2954	0.0000
NW	0.0367	0.1338	0.1667	0.3783	0.0887	0.1959	0.0000
WNW	0.0179	0.1259	0.1877	0.4097	0.0661	0.1926	0.0000
W	0.0650	0.2801	0.1804	0.2975	0.0295	0.1474	0.0000
WSW	0.1381	0.0410	0.2127	0.1866	0.0410	0.3806	0.0000
SW	0.0875	0.2602	0.0852	0.1832	0.0665	0.3174	0.0000
SSW	0.0754	0.1447	0.1156	0.3106	0.0452	0.3085	0.0000
S	0.0464	0.1383	0.1320	0.2285	0.1295	0.3254	0.0000
SSE	0.0290	0.1021	0.1406	0.2746	0.1637	0.2899	0.0000
SE	0.0103	0.0722	0.1104	0.1905	0.2485	0.3682	0.0000
ESE	0.0188	0.0387	0.0695	0.2171	0.3169	0.3391	0.0000
E	0.0111	0.0827	0.0998	0.3827	0.1368	0.2869	0.0000
ENE	0.0238	0.0680	0.1257	0.4770	0.1423	0.1633	0.0000
NE	0.0486	0.1099	0.1260	0.4649	0.0564	0.1943	0.0000
NNE	0.0437	0.1148	0.1547	0.4117	0.0758	0.1992	0.0000

FREQUENCIES OF WIND DIRECTIONS AND RECIPROCAL-AVERAGED WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.027	0.98	1.28	1.83	2.64	3.55	0.93	0.00
NNW	0.044	0.77	0.98	2.33	3.86	3.43	1.00	0.00
NW	0.112	0.96	1.19	2.53	3.62	3.52	0.96	0.00
WNW	0.083	0.92	1.26	2.73	3.84	3.46	0.99	0.00
W	0.012	0.77	1.13	1.89	2.09	2.97	0.81	0.00
WSW	0.003	0.77	4.37	4.37	1.76	4.37	1.01	0.00
SW	0.009	0.77	0.99	1.14	1.29	3.09	0.90	0.00
SSW	0.010	0.77	1.35	1.73	3.03	3.73	0.92	0.00
S	0.056	0.88	1.06	2.05	3.51	3.87	0.96	0.00
SSE	0.129	0.89	1.02	2.25	4.33	4.12	1.08	0.00
SE	0.182	0.88	0.98	2.07	3.46	4.12	1.02	0.00
ESE	0.139	0.95	1.16	2.34	4.55	4.09	1.09	0.00
E	0.068	0.98	1.11	2.44	5.23	3.87	1.03	0.00
ENE	0.062	0.92	1.27	3.20	5.88	4.08	1.07	0.00
NE	0.038	0.84	1.18	2.50	4.48	3.58	0.97	0.00
NNE	0.026	0.90	1.57	3.04	3.79	3.39	0.95	0.00

FREQUENCIES OF WIND DIRECTIONS AND TRUE-AVERAGE WIND SPEEDS

WIND TOWARD	FREQUENCY	WIND SPEEDS FOR EACH STABILITY CLASS (METERS/SEC)						
		A	B	C	D	E	F	G
N	0.027	1.32	2.17	3.37	4.87	3.77	1.20	0.00
NNW	0.044	0.77	1.52	3.56	5.73	3.66	1.37	0.00
NW	0.112	1.27	1.95	3.73	5.72	3.75	1.28	0.00
WNW	0.083	1.18	2.09	4.14	5.84	3.70	1.34	0.00
W	0.012	0.77	1.79	2.94	3.98	3.15	0.89	0.00
WSW	0.003	0.77	4.37	4.37	4.01	4.37	1.37	0.00
SW	0.009	0.77	1.41	1.61	2.59	3.30	1.15	0.00
SSW	0.010	0.77	2.35	3.16	4.91	3.93	1.18	0.00
S	0.056	1.09	1.77	3.25	5.13	4.03	1.29	0.00
SSE	0.129	1.10	1.54	3.51	5.74	4.22	1.50	0.00
SE	0.182	1.10	1.53	3.14	5.31	4.21	1.39	0.00
ESE	0.139	1.25	1.95	3.38	6.23	4.19	1.51	0.00
E	0.068	1.32	1.73	3.82	6.68	4.04	1.42	0.00
ENE	0.062	1.18	2.17	5.21	7.45	4.19	1.50	0.00
NE	0.038	0.99	1.94	3.98	6.66	3.80	1.29	0.00
NNE	0.026	1.14	2.66	4.74	6.13	3.63	1.25	0.00

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 15 1991

OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Bluewater Uranium Mine Preliminary Assessment Data

FROM: Richard J. Guimond, Director (ANR-458)
Office of Radiation Programs

TO: Jeffrey Zelikson, Director
Hazardous Waste Management Division, Region 9

This is an interim response to a memorandum, dated January 29, 1991, to me from Donald C. White, Chief, Field Operations Branch, Region 9. I understand that Mr. White also sent a nearly identical memorandum to Steven Luftig, Director of Superfund's Environmental Response Division. These memoranda from Mr. White requested the assistance of the Office of Radiation Programs (ORP) and the Office of Solid Waste and Emergency Response (OSWER) in interpreting the results of a radiological survey of inactive uranium mines in Bluewater, NM. Mr. White also asked for help in determining whether the sites warrant either a removal or remedial action under the Comprehensive Environmental Response, Compensation and Liability Act, as amended by the Superfund Amendments and Reauthorization Act (CERCLA/SARA).

On March 14, my staff briefed me on the Bluewater sites. We examined the preliminary assessment reports and other information provided by the Navajo Superfund Office (NSO), the Public Health Advisory of the Agency for Toxic Substances and Disease Registry (ATSDR) dated November 21, 1990, and the results of a preliminary radiation survey carried out by members of my office at our Las Vegas Facility on November 13 through 16, 1990.

The memorandum requires answers to four questions: 1) Are the existing data adequate for a determination of the risks associated with the sites; 2) if so, what are the levels of risk; 3) by what scientifically sound and legally defensible criteria can and should OSWER undertake a removal (as opposed to a remedial) action; and, 4) are there any relevant and useful precedents?

Based on our evaluation of the information available, I believe that there may be a significant risk posed by at least one of the sites. I feel, however, that in order to make informed recommendations in response to the memorandum, it is necessary to obtain additional information. This need was discussed in depth in a telephone conversation on March 21, involving Mr. White; Bob Dyer, Gregg Dempsey, Colleen Petullo, and Tony Wolbarst of my staff; Michael Bandrowski, the Region 9 Radiation Program Manager; and Karen Tomimatsu and Pamela Harris of OSWER HQ.

I have directed our Las Vegas Office to draft a sampling and data analysis workplan for assessing releases of radionuclides into pathways not already evaluated. The assessment would cover:

- radon and gamma-ray exposure in homes (of concern because radium-bearing materials may have been used in construction);

- radon emanating from mine vents;

- radionuclides in all realistically accessible sources of ground and surface waters;

- radionuclides entering the food chain.

In my opinion, it is also important to carry out a more extensive, and statistically more rigorous, gamma-ray survey of the sites, taking fully into account land-use by the inhabitants. All components of this extended survey should include involvement of and close cooperation with the Navajo Superfund Office and Indian Health Service. Further, I suggest that you consider an aerial radiological survey of the sites in order to provide an overview of the extent of the contamination problem.

Since it may be appropriate to consider these sites for remedial as well as, or instead of, removal action, the additional data should be obtained in a form suitable for site scoring using the revised Hazard Ranking System (HRS). Section 7 of the revised HRS provides instruction for evaluating sites containing radioactive substances.

I have requested the assistance of Superfund's Emergency Response Division in determining what criteria are or have been used to trigger Agency removal actions. Also, I am coordinating with them and with Michael Bandrowski in soliciting input on this issue from the ten Regional Superfund Offices. In view of the significant legal implications of any recommendations that I may offer, I feel that Regional Council and/or OSWER Council should be actively involved in the process.

I appreciate the importance of this problem, and consider it to be of high priority. I expect that as soon as more complete information on the nature of the hazards at Bluewater becomes available, I shall be able to provide a more complete response to the questions posed in the memorandum.

cc: Steven Luftig (OS-210)
Donald C. White, EPA/Region 9
Martin Halper (ANR-461)
Raymond Brandwein (ANR-458)
Robert Dyer (ANR-461)
Anthony Wolbarst (ANR-461)
Mark Mjoness (OS-210)
Pamela R. Harris (OS-210)
Karen Tomimatsu (OS-210)
Michael Bandrowski, EPA/Region 9
Robert Bornstein, EPA/Region 9
William Weis, EPA/Region 9
Gregg Dempsey, ORP/LVF
Colleen Petullo, ORP/LVF
Joanne Manygoats, NSO
William Nelson, ATSDR

DATE: 4/16

U.S. ENVIRONMENTAL PROTECTION AGENGY
ANALYSIS AND SUPPORT DIVISION
OFFICE OF RADIATION PROGRAMS (ANR-461)
WASHINGTON D.C. 20460
FAX NUMBER 382-6918

TO: BILL WEIS FAX.NO 8-484-1916

FROM: TONY WOLBARST TEL. NO: 8-475-9630

TRANSMITTED ARE 4 PAGES (INCLUDING COVER)

REMARKS

MEMORANDUM OF CALL

Previous editions usable

TO Bill

YOU WERE CALLED BY— YOU WERE VISITED BY—

Tony Wolbarst

OF (Organization)

PLEASE PHONE ▶ FTS AUTOVON

475-9630

WILL CALL AGAIN IS WAITING TO SEE YOU

RETURNED YOUR CALL WISHES AN APPOINTMENT

MESSAGE

Faxing Rich Guimond's signed memo

RECEIVED BY | DATE 4/16 | TIME 1:23

63-110 NSN 7540-00-634-4018 STANDARD FORM 63 (Rev. 8-81) Prescribed by GSA FPMR (41 CFR) 101-11.6

U.S. GPO: 1990 — 262-080

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 15 1991

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William Weis, EPA/Region 9
Gregg Dempsey, ORP/LVF
Colleen Petullo, ORP/LVF
Joanne Manygoats, NSO
William Nelson, ATSDR

RISK ASSESSMENTS OF HAZARDS AT THE BLUEWATER URANIUM MINE SITES

by
DR. GAURAV RAJEN
NAVAJO SUPERFUND PROGRAM,
NAVAJO ENVIRONMENTAL PROTECTION ADMINSTRATION,
NAVAJO NATION, WINDOW ROCK, AZ, 86515

SUMMARY

This risk assessment uses conservative assumptions that are protective of human health. The assumptions represent feasible scenarios, that are not neccessarily the worst possible. The conclusions of this study are that the excess fatal cancer risks posed by the hazards at the Bluewater uranium mine sites are greater than 1 in 10,000. The risks are calculated for exposures of one year as well as a lifetime.

1.0 INTRODUCTION: PROJECT HISTORY

This report presents a preliminary risk assessment of some of the hazards existing at the Brown-Vandever, Nanabah-Vandever, and the Desiderio Group abandoned uranium mines (collectively called the Bluewater uranium mine sites). The aim of the preliminary risk assessment is to establish whether an "increased carcinogenic health risk of 1 in 10,000 or more after a two year exposure" exists at the site (Bornstein, 1991; Appendix I). If the level of risk is greater than or equal to 1 in 10,000 for a two year exposure, then a removal action could be warranted at the sites. This risk assessment is based on data gathered by personnel of the U.S. Environmental Protection Agency (EPA) and the Navajo Superfund Program on a site inspection carried out from November 13-16, 1990. (Appendix I provides a report of this inspection). Additional data, gathered by staff of the Navajo Superfund Program prior to and after this site inspection, has also been used. The spirit in which this risk assessment is performed is to determine whether a risk greater than 1 in 10,000 exists at the sites; that is, to determine if a removal action is warranted at the sites. The risk assessment does not purport to be a complete assessment. It is detailed enough, however, to demonstrate that the excess cancer risks posed by the hazards at the sites are far greater than 1 in 10,000.

The history of the project is as follows:

The Brown-Vandever, Nanabah-Vandever, and the Desiderio Group abandoned uranium mines were initially assessed by the Navajo Superfund Program as part of the pre-remedial process authorized under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986 (SARA). Preliminary Assessment (PA) reports on the Brown Vandever, Nanabah Vandever, and the Desiderio Group sites were submitted on 5/5/90, 7/6/90, and 8/1/90, respectively. The Hazard Ranking System (HRS) scores for the Brown Vandever, Nanabah Vandever, and the Desiderio Group sites were projected to be 45.03, 31.36, and 38.72. (Note: HRS scores are confidential information). The Brown Vandever and the Nanabah Vandever mines are on the same property, and in this report whenever reference is made to the Brown Vandever site, the Nanabah Vandever mine will be considered a part of the Brown Vandever site. After a review of the PA reports, and the computation procedures used to determine the HRS scores, the Superfund Site Assessment Section of the U.S. EPA Region VI recommended high priority Screening Site Inspections (SSIs) in August and September of 1990. In October, 1990, U.S. EPA Region IX became the lead agency for the Navajo Nation, and responsibility for the project was transferred to Region IX.

Based on the work of the Navajo Superfund Program, and site visits by personnel, the Agency for Toxic Substances and Disease

Registry (ATSDR), issued a Public Health Advisory for the sites on November 21, 1990. Draft versions of the Public Health Advisory were distributed to appropriate agencies before November 21, 1990.

The Emergency Response Section of the U.S. EPA Region IX performed a site inspection of the concerned sites between November 13-16, 1990. This site inspection was conducted with the assistance of staff of the Navajo Superfund Program, and support personnel from the U.S. EPA's Office of Air and Radiation. The data obtained from this site inspection will be used by the Navajo Superfund Program to create SSI reports and revised HRS scores for the sites. The data is also being used by staff of the U.S. EPA's Office of Air and Radiation to prepare a risk assessment for the sites. In an effort to share its understanding of the situation at the sites, and the existing risks, the Navajo Superfund Program has prepared this report.

2.0 TYPES OF WASTES

The waste piles left behind after uranium mining operations cease usually consist of waste rock, sub-ore, and ore-grade material. The waste piles contain elevated levels of heavy metals, such as arsenic, lead, selenium, and vanadium. Radionuclides present in the waste are uranium and its radioactive progenies. The wastes that are present on the sites are in the form of unstabilized piles, of large quantities, and in a particulate form. This increases the hazard posed by the wastes considerably. If the wastes were contained, they would not be free to migrate off the sites. In their present form and state, they create a significant potential for fugitive dusts and leachate to be produced. Appendix I provides a summary of the data that has been collected on the concentrations of radionuclides in the wastes.

3.0 HEALTH IMPACTS

The principal hazards to human health associated with the abandoned uranium mines are:

1) - direct ingestion of contaminants through on-site exposure

2) - inhalation of radon gas and radon daughters emanating from the sites

3) - inhalation and ingestion of airborne contaminant particulates

4) - direct exposure to ionizing radiation emitted from the wastes

5) - ingestion of ground and surface water contaminated with the mine waste

ingested) for the radionuclides of concern are:

Radionuclide	Slope Factor (risk/pCi ingested)
U-234	1.4 E-10
U-235	1.3 E-10
U-238	1.3 E-10
Th-230	2.4 E-11
Ra-226	1.2 E-10

Let us consider the risks for the ingestion of radionuclides for a person who has lived twenty-five years at the site. This is the amount of time that the waste has already been present on the site. For 5 years the consumption rate is assumed to be that of a child, and for 20 years the consumption rate is assumed to be that of an adult. The excess fatal cancer risk for this person, therefore, will be:

Radionuclide	Risk for a 25 year consumption
U-234	3.06 E-5
U-235	0.29 E-5
U-238	2.4 E-5
Th-230	2.84 E-5
Ra-226	2.62 E-5
Total:	1.121 E-4

The risks for excess fatal cancers from soil ingestion for twenty-five years are of the order of 1.12 E-4. Residents at the sites have been exposed to these wastes for twenty-five years or more. Several of the adult males have worked in uranium mines. For the residents, the additional exposures they will receive in two more years will add to the risks that are already of the order of 10 E-4 or greater.

3.3 Inhalation of Radon and Radon Daughters

Studies on radon release from inactive open pit uranium mines have established that the radon fluxes can be as high as fourteen times the background levels for the area. (Thomas, Nielson, Mauch, 1982). The piles of mine waste, therefore, could be releasing radon gas at flux levels much higher than what are

U-238	200 pCi/g
Th-230	100 pCi/g
Ra-226	200 pCi/g

The actual concentrations of radionuclides in the waste and the soil vary by several orders of magnitude. In some areas, for instance, Ra-226 concentrations have been found to be as high as 450 pCi/g; and U-238 concentrations as high as 390 pCi/g. Also, only fine particles of soil were analyzed. Coarse particles that were not analyzed can be assumed to have similar, if not greater, concentrations of radionuclides. Therefore, in a given surface area and depth of waste that contains both fine and coarse particles the concentration of radionuclides could be greater than what has been measured simply from the fine particles. The values assumed here are meant to be representative of the sites. At the Desiderio site, samples were not collected from areas which had very high gamma radiation levels: for instance, Figure 9 in Appendix I shows areas which have gamma radiation levels of 800 microR/h and 900 microR/h, but soil samples were not collected in these areas. Soil samples collected in areas with gamma radiation levels of about 135 microR/h have radionuclide concentrations of the order of 30 pCi/g. Extrapolating from these numbers, and assuming a similarity in the wastes at the sites, the source at the Desiderio site is assumed to have radionuclide concentrations that are the same as those at the Brown Vandever site in the areas where soil ingestion is assumed to occur. The concentrations of Th-230 have been assumed from values obtained in the analyses of waste from other abandoned uranium mine. It is important to note that the concentrations assumed are meant to be representative of the sites.

The yearly consumptions of radionuclides at the Brown Vandever and the Desiderio sites will therefore be:

Radionuclide	Yearly Consumption	
	Adult	Child
U-234	7300 pCi/y	14600 pCi/y
U-235	730 pCi/y	1460 pCi/y
U-238	7300 pCi/y	14600 pCi/y
Th-230	3650 pCi/y	7300 pCi/y
Ra-226	7300 pCi/y	14600 pCi/y

The health effects of the ingestion of radionuclides can be estimated using cancer slope factors and unit risk values for the radionuclides. (Appendix III). The slope factors (risk per pCi ingested) for the radionuclides of concern are:

0-1/4 mile radius: 65 people
1/4-1/2 mile radius: 0
1/2-1 mile radius: 93 people
1-2 mile radius: 197 people
2-3 mile radius: 149 people
3-4 mile radius: 62 people

3.1.5.2 Desiderio Site

On-site: 10 adults (5 males, 5 females); 9 children (7 go to school, 2 do not).

(The following figures are estimates based on the number of houses in the area and by assuming the average number of residents per house. The figures are not obtained by an actual house count.)

0-1/4 mile radius: 0
1/4-1/2 mile radius: 0
1/2-1 mile radius: 10 people
1-2 mile radius: 41 people
2-3 mile radius: 10 people
3-4 mile radius: 62 people

3.2 Direct Ingestion of Wastes

All the areas of mine waste at the sites show evidence of visitation by humans and livestock. The easy accessibility of the waste piles, the lack of fences, and warning signs, and the proximity of residences make this hazard a very real threat. Children are known to play on and around the piles of mine waste. In the past, the mine waste material has been used for the construction of homes. At one of the sites, it has also been used to pave a road surface.

The adult consumption of contaminated soil by daily visitation to the contaminated areas can be assumed to be 100 mg/day, and the consumption of contaminated soil by a child up till the age of 5 years can be assumed to be 200 mg/day. (Seidel, 1991). In estimating the risk from soil ingestion, we must assume that the soil may be consumed primarily from the most contaminated areas. These areas are in close proximity to the residences, and attractive to adults and children for work and play. The radionuclide concentrations in the soil are assumed to be as follows:

Radionuclide	Concentration
U-234	200 pCi/g
U-235	20 pCi/g

day is about 2 hours. Week-ends are spent on the site, with 6 hours per day outside, and the rest inside the home. In the other scenario, the male stays on the site on a regular basis. 6 hours every day are spent outside the home. We estimate that in this scenario the adult male leaves the site about twelve hours every month.

3.1.2 Adult Female

For the adult female, there are two scenarios possible. In one, the female leaves home every working day, five days a week, for about 8 - 10 hours per day. The rest of the day is spent inside the home, or on the site. The time outside the home is about 2 hours. Week-ends are spent on the site, with 4 hours per day outside, and the rest inside the house. In the other scenario, the female stays on the site on a regular basis. 4 hours every day are spent outside the home. We estimate that in this scenario the adult female leaves the site about twelve hours every month.

3.1.3 Children

School-going children leave the site five days a week from 7:00 a.m. till 4:00 p.m. (One child goes to school 4 days a week, from 7:00 a.m. till 2:00 p.m.). The children spend about 2 1/2 hours every day playing outside. Week-ends are spent on the site, with about 6 hours spent playing outside the homes, and the rest of the time indoors. Children who do not go to school spend approximately 5 hours every day outside the home, and the rest indoors.

3.1.4 Sheep-herder scenario

The time spent grazing sheep is about 7 hours every day. These duties are shared by different adults and children. However, as it is not possible to estimate which individuals share the duties, and how many times, a scenario can be built for a sheep-herder based on the assumption that the same individual herds the sheep for 7 hours on the site every day.

3.1.5 Near-by residents

The number of residents living on and near the Brown Vandever and the Desiderio sites is as follows:

3.1.5.1 Brown Vandever Site

On-site: 13 adults (7 males, 6 females); 10 children (4 go to school, 6 do not).

(The following figures are estimates based on the number of houses in the area and by assuming the average number of residents per house. The figures are not obtained by an actual house count.)

well as inhalation and intake levels, and working levels for residents around the mine. They used the DARTAB code (Begovitch, Schlatter, and Ohr, 1980) to calculate dose and risk using the AIRDOS-EPA output. Dose and risk conversion factors were calculated from the RADRISK code (Dunning et al, 1979). Another code that can be used for human risk assessment modelling is the DECHEM code developed for uranium mill tailings disposal sites (DOE, 1989). This code can be used to model risks associated with radioactive contaminants, as well as non-radioactive contaminants.

In this risk assessment, use is made of the AIRDOS-PC code (EPA,1991). This code is used to estimate risks posed by airborne radionuclides emanating from the sources on the site. The AIRDOS-PC code is similar to the AIRDOS-EPA code, except that it does not calculate risks from radon, and runs on a PC, as opposed to a main-frame computer.

The Navajo Superfund program is presently developing risk assessments for all the hazards present at the sites. Different scenarios have been built to estimate the health impacts at the sites.

3.1 Estimates of how residents spend their time

The assessment of the risks posed to residents at the sites is contingent upon some knowledge of how they spend their time on and off the site. Estimates of how the residents spend their time have been made through interviews with the residents. There is no way of ensuring, however, that they will continue to adhere to a certain pattern of time usage over a given length of time. Risk estimates, therefore, should be based on assumptions that model the worst feasible cases.

The interviews have shown that how residents spend their time is best characterized in terms of two scenarios: residents who leave the site regularly, and those who do not. The residents cannot afford to, and do not, as a rule, take vacations every year, or leave their homes for extended periods.

Another important fact is that in the summer months, the residents tend to spend much larger amounts of time outside the home, and often spend time in the shade of trees where it is cool. (This is a direct quote from one of the residents.) This fact should be incorporated into the estimates provided below for the summer months, by adding some hours to the time spent outside the home, and subtracting from the time spent inside the homes.

3.1.1 Adult Male

For the adult male, there are two scenarios possible. In one, the male leaves home every working day, five days a week, for about 8 - 10 hours per day. The rest of the day is spent inside the home, or on the site. The time outside the home every

6) - ingestion of contaminated foods produced in areas contaminated by the mine wastes

7) - physical hazards associated with shafts, boreholes, open pits, unsafe structures.

Health impact estimates for inactive uranium mines have been performed by several researchers. Hans, Eadie, and O'Connell, (1981), for instance, developed models of inactive surface and underground uranium mines, and estimated the individual lifetime fatal cancer risk for one year of exposure from airborne radioactive emissions. The study assumed that a maximally exposed individual resided 1600 meters (one mile) away from the mine, and was exposed to airborne radioactive particulates and radon-222 and radon-222 daughters. The individual lifetime fatal cancer risk for one year of exposure was estimated to be 4.7E-7 for an inactive surface uranium mine, and 2.8E-7 for an inactive underground uranium mine.

Unlike the assumptions of the study by Hans, Eadie, and O'Connell (1981) in which the maximally exposed individual lives 1600 meters from the site, at the Bluewater uranium mine sites, residents live approximately 20 meters of the mines and the mine waste. The quantities of mine waste existing at the Bluewater uranium mine sites are also much greater than those assumed to exist at the model mines. The residents are exposed not only to airborne radioactive particulates, but also live and work on contaminated soil. The residents also consume sheep that graze on the contaminated soil. Gamma exposure rates at the mines that were studied by Hans, Eadie, and O'Connell (1981) to develop their model mines ranged to a maximum of about 400 microRoentgen/hour. At the Bluewater uranium mine sites, gamma exposure rates have been measured to be several times higher: up to 2500 microRoentgen/hour at localized "hot spots", and up to 1000 microRoentgen/hour generally in some areas. The radon flux at the model mines from sub-ore material was assumed to be of the order of 12 pCi/m^{1}-s. At the Bluewater uranium mine sites, the radon flux measured at one of the piles is of the order of 100 pCi/m^{1}-s. For all of these reasons, it is likely that risks associated with the Bluewater uranium mine sites will be much greater than those estimated for model inactive uranium mines by Hans, Eadie and O'Connell (1981). A study by Blanchard, Fowler, Horton, and Smith (1981) found that the estimated risk of fatal lung cancer that could occur to individuals living in houses built on land contaminated by uranium mine wastes ranged from 2.5 per 100 persons to 15 per 100 persons, for soil containing Ra-226 concentrations of 5 pCi/g to 30 pCi/g, respectively.

Although it does not apply directly, the study by Hans, Eadie, and O'Connell (1981) is useful in providing guidelines and methodologies for estimating some of the health risks associated with the Bluewater inactive uranium mines. Hans, Eadie, and O'Connell (1981) used the AIRDOS-EPA code (Moore et al, 1979) to calculate radionuclide releases from the mine through the air as two months or more. The alpha-track devices that were placed are as follows:

Number	Place	Date Placed	Date Retrieved	Reading
974089	Brown Vandever residence	10/23/90	1/10/91	2.6 pCi/l
974080	Jenny Desiderio residence	10/23/90	1/10/91	1.5 pCi/l
974088	Joanne Desiderio	11/01/90	1/10/91	3.3 pCi/l
974087	Harry Desiderio residence	11/01/90	1/10/91	4.6 pCi/l
974086	John Ray Desiderio residence	11/01/90	1/10/91	3.0 pCi/l

The concentrations within the homes are not very high. However, it should be noted that the homes are well ventilated. The ambient air standard for radon (40 CFR 192) is that the radon concentration should not be greater than 0.5 pCi/l over the background. For homes, a level at which further testing is deemed necessary is 4.0 pCi/l. Only one of the homes has shown a radon concentration greater than 4.0 pCi/l. These preliminary readings are not sufficient to establish the radon concentrations that must be present within the homes throughout the year. It is clear from the flux measurements that high levels of radon gas are emanating from the piles of mine waste present in close proximity to the homes. An extremely high concentration of radon gas has also been measured near a ventilation shaft at the Brown Vandever site.

Radon gas and its daughter products must be contributing to the overall exposure of the residents at and near the sites. An estimate of the surface area of the waste piles and the radon flux emanating from the waste piles will allow the exposure from the radon gas to be assessed. To assess the working levels that exist near the waste piles, based on the radon flux emanating from the piles, requires the use of computer models that are not available to the Navajo Superfund Program.

The mine vent at which the concentration of radon was measured to be 5114.6 pCi/l is located in an area that is often frequented by the residents. Concern for the safety of the children who play in the area has led to the residents placing drums over the vent holes, and placing warning signs next to the drums. The radon concentration was measured by placing a charcoal cannister adjacent to one of the drums. If we assume that the radon at this location is in radioactive equilibrium, and that a person spends one hour a day at this location, the annual WLM (working-level-month) exposure turns out to be - 108 WLM! This considered safe.

On 11/15/90, forty-seven activated charcoal cannisters were buried into the surface of a pile of mine waste at the Desiderio site. These cannisters were picked up after 24 hours on 11/16/90. The results of this measurement provide an estimate of the radon flux that is emanating from the piles of mine waste. The average radon flux that has been found to be emanating from three areas at the location of measurement is 51.4, 67.0, and 47.7 pCi/sq.m/s. Some of the cannisters gave flux readings as high as 143 pCi/sq.m/s. The radon flux at this location is, therefore, of the order of 100 pCi/sq.m/s. A design criterion for uranium mill tailings covers stipulates that the maximum allowable radon flux emanating from the covered tailings should be 20 pCi/ sq. m./s. (U.S. EPA, 1989). Although the waste pile at which measurements were made is not one of the highly radioactive piles of mine waste at the sites, it represents one of the "average" piles. The concentration of Ra-226 at this location has been measured to be about 30 pCi/g. At other locations at the sites, the Ra-226 concentrations have been found to be as high as 450 pCi/g. At such locations the radon flux must be much higher.

A measurement of radon concentration near a ventilation shaft at the Brown Vandever site using an activated charcoal cannister has been performed by the Navajo Superfund Program. The value obtained was 5114.6 pCi/l. Figure 1 illustrates a picture of the activated charcoal cannister placed adjacent to a drum covering the ventilation shaft.

All of these indicators point to the fact that elevated levels of radon gas are emanating from the piles of mine waste. The radon gas will have a severe impact on humans residing in the environs of the sites.

Activated charcoal cannisters were placed in some of the homes at the sites. These cannisters were in place for one week. The charcoal cannisters that were placed and the radon concentrations measured are as follows:

Number	Place	Date Placed	Date Retrieved	Reading
NAV9001	Jenny Desiderio residence	11/15/90	11/22/90	3.3 pCi/l
NAV9002	Near ventilation shaft at Brown Vandever	11/15/90	11/22/90	5114.6 pCi/l
NAV9003	Lena Vandever residence	11/15/90	11/22/90	2.0 pCi/l

Alpha-track devices were also placed in homes at the sites by staff of the Navajo Superfund Program and were in place for number is calculated as follows: a concentration of 100 pCi/l in radioactive equilibrium is equivalent to 1 working level (WL). An exposure of 1 WL for 170 hours is equal to 1 working-level-month (WLM). Therefore, a concentration of 5114.6 pCi/l, assumed to be in radioactive equilibrium, and an exposure to this concentration of 30 hours per month for 12 months, works out to an exposure of

$$(51.146 \times 30 \times 12/\ 170) = 108.31 \quad WLM/y.$$

It is important to note that this location is not the only mine vent which is exhaling radon gas at the Brown Vandever and the Desiderio sites. At both the sites, there exist large shafts that open into the mines.

The conversion factor to estimate the risk from radon exposure is 0.021 fatal cancers/person-WL-y (Silhanek and Andrews, 1981). An exposure of one person to 51.146 WL for 1 hour per day works out to 2.131 person-WL-y. Therefore, the excess fatal cancer risk works out to be 4.45 E-2.

3.4 Airborne Contaminants

At present, there is very scanty data on the air mobility of contaminants at the sites. The particulate nature of the wastes creates a significant possibility of airborne transport of contaminants from the sites. A study on aerosol release from open pit uranium mining indicates that downwind of open ore piles there is a fifty fold uranium enrichment of aerosols. (Thomas, Nielson, and Mauch, 1982).

The release of particulates from a waste pile from an underground uranium mine has been estimated by Hubbard (1976) to be 2.12 MT (metric tons)/hectare-year. Hans, Eadie, and O'Connell, (1981) used this emission factor to estimate the releases from an underground uranium mine. For a surface uranium mine, they estimated the releases to be 10 times larger. The Brown Vandever and the Desiderio mines were surface mines combined with underground mining. Therefore, at these sites, similar to the assumptions of Hans, Eadie, and O'Connell (1981), we shall assume that the emission rate is 10 times the rate estimated for an underground mine. To perform order of magnitude calculations, we assume that the surface area of the sources at the Brown Vandever mine is 5000 sq.m. At the Desiderio site the surface area of the sources is assumed to be 2500 sq.m. The concentrations of radionuclides at the two sites, averaged over the assumed area of the source, are assumed to be:

Radionuclide	Concentration	
	Brown Vandever	Desiderio
U-234	100 pCi/g	50 pCi/g
U-235	10 pCi/g	5 pCi/g

U-238	100 pCi/g	50 pCi/g
Th-230	50 pCi/g	25 pCi/g
Ra-226	100 pCi/g	50 pCi/g

It is important to note that the source areas and the averaged concentrations assumed over the areas are meant to be representative of the sites, and not exact.

Multiplying the emission factor of 21.2 MT (metric tons)/hectare-year by the concentrations of the radionuclides and the assumed areas of the sources, the releases of different radionuclides into the air at the sites are as follows:

Radionuclide	Releases	
	Brown Vandever	Desiderio
U-234	1 E-3 Ci/y	5 E-4 Ci/y
U-235	1 E-4 Ci/y	5 E-5 Ci/y
U-238	1 E-3 Ci/y	5 E-4 Ci/y
Th-230	5 E-4 Ci/y	2.5 E-4 Ci/y
Ra-226	1 E-3 Ci/y	5 E-3 Ci/y

The results of the AIRDOS-PC model are presented in Appendix II. Wind data for Grants, New Mexico, is used in the model. Other assumptions regarding mean annual rainfall, etc., necessary to run the model are described in Appendix II. Using the assumed release rates, and areas of the sources, the effective dose equivalent for a person living 300 meters away from the source works out to be 5.7 E-3 rem/y for the Desiderio site, and 1.1 E-2 rem/y for the Brown Vandever site. The highest organ dose is to the lungs, and works out to be 3.7 E-2 rem/y for the Desiderio site, and 7.4 E-2 rem/y for the Brown Vandever site. AIRDOS-PC calculates exposures for people living a closest distance of 300 meters from the source. At the Brown Vandever, and the Desiderio sites, people live within 20 meters of contaminated material. The exposures must therefore be much greater than those calculated using AIRDOS-PC.

The excess fatal cancer risk from the calculated exposures can be estimated as follows. For a whole body exposure, the NCRP (1987) estimates an excess fatal cancer risk of 10 E-4 per rem of whole body exposure for a year for a person. At the Brown Vandever and the Desiderio sites, the excess fatal cancer risk, therefore, is 1.1 E-6 and 6.0 E-7, respectively, for a person living 300 meters away from the source, and for a year's exposure. The actual risk is much greater, as people live in much closer proximity to the sources than 300 meters. The Biological Effects of Ionizing Radiation Report V (BEIR V), released by the national research Council, (NRC, 1990), places the excess fatal cancer risk for a lifetime exposure to 0.1 rem per year as 5.2 E-3. For an exposure of approximately 1 E-2 rem/year for a lifetime, the excess cancer risk is, therefore, of the order of 5.2 E-4, for a person living 300 meters away from the source at all times. As the residents at the sites live much closer than 300 meters away, and also work and play on the waste piles, the risks they face are much greater. Obviously, a person walking on the waste pile is likely to breathe in much more contaminated dust than a person who only comes within 300 meters of the waste pile.

3.5 Direct Exposure to Ionizing Radiation

The worst feasible case for direct exposure to ionizing radiation for a resident is that of the sheepherder who would frequent the waste piles on a regular basis. Let us assume that this person spends four hours every day in a zone that has readings of about 500 microrems/hour. In one year (365 days), this person would be exposed to 730 millirems. The excess fatal cancer risk for an exposure of 0.1 rem per year for a lifetime is 5.2 E-3. (NRC, 1990). Therefore, the excess fatal cancer risk for an exposure of 0.73 rem per year for a lifetime is 3.8 E-2.

3.6 Ingestion of Contaminated Food and Water

In the investigations to date, no samples of biota that exist at the sites have been collected. There exists a need for studies on the accumulation of radionuclides and heavy metals in plants and livestock on and around the sites. Extensive grazing of sheep takes place at the sites. A limited study on radionuclide levels in cattle raised near uranium mines and mills in northwest New Mexico estimated risks as high as 1 in 14,000 for individuals that ate contaminated meat for twenty years. (Lapham, Hillard, and Samet, 1986). In this study, risk estimates were made for cattle that grazed near uranium mines and mills. The cattle did not graze directly on the waste piles. At the Brown Vandever and the Desiderio site, the sheep graze on the waste piles. They must, therefore, accumulate radionuclides to a greater extent than the cattle analyzed in the study by Lapham, Millard, and Samet (1986).

The risks from the ingestion of contaminated water cannot be fully assessed at this time. One of the water samples collected which appears to have extremely high levels of radionuclides needs to be re-sampled. If one of the samples is in error, there is a possibilty that there are errors in the other samples as well.

3.7 Physical Hazards

Very few of the sites have fences or warning signs. However, the physical hazards at the sites pose extreme dangers to humans. There are numerous vertical mine shafts and boreholes which are several hundred feet deep. Some of the sites contain precipitous open pits, and a few of the sites also contain unsafe structures, such as loading bays, etc.

3.8 Cumulative risks and conclusions

The cumulative risks from soil ingestion, radon, airborne particulates and external exposure to ionizing radiation, range between 1 in 100 to 1 in 10000 for the two sites.

The risks are greater than the 1 in 10,000 criterion to be used to determine whether a removal action is needed.

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IX

75 Hawthorne Street

San Francisco, Ca. 94105

May 30, 1991

Memorandum

Subject: **Navajo Bluewater Site - Preliminary Risk Assessment**

From: Sharon Seidel, Ph.D.
Region IX Toxicologist (H-8-4)

Sharon Seidel

To: Robert Bornstein
On-Scene Coordinator (H-8-3)

I reviewed the EPA ERS Preliminary Assessment Data for the Bluewater uranium mine site. Human health risks for both the Brown-Vanderver and the Desiderio areas exceed 10^{-4} for a 2 year exposure period. The exposure pathways for which risks were quantified include external gamma exposure and ingestion of soil contaminated with radionuclides. Additionally, risks from inhalation exposure to radon/radon decay products from the mine tailings have been estimated to occur in the 10^{-4} risk range over a 2-year exposure period, for an individual 100 meters downwind from the source. Risk calculations and exposure assumptions are summarized on the following pages of this memo. Risks are also provided for a 5-year exposure period - assuming the interval between site discovery and site listing/interim remedial action exceeds 2 years, and for a 50-70 year exposure period - assuming the site is not listed on the NPL and no remedial action occurs.

Additional pathways of concern at this site include (1) **fugitive dust exposure** from the mine wastes, (2) **exposure to ephemeral surface waters** pooling on-site (through external contact (swimming or wading) and casual ingestion), (3) **ingestion of contaminated food**, (4) exposure to **radon in homes,** (5) exposure to radionuclides from **contaminated soil particulates adhering to sheep wool** as it is handled during preparation for weaving, and (6) exposure to tailing material which may have been intentionally or unintentionally moved to the vicinity of the homes, subsequently becoming a **near-field attractive hazard,** particularly for children.

While external gamma exposure, radon flux and ingestion of contaminated soils from the mine piles may reasonably be expected to be reduced by the proposed ERS action of covering the piles, exposures which may not be reduced potentially include pathways 3 - 6, and conceivably pathway 2 (via contaminant leaching through the soil cover). Further site investigation is recommended to address these potential pathways, including (a) **sampling of surface waters** for radionuclides and heavy metals, (b) **analysis of sheep and other locally grown food** for radionuclide contamination, (c) an **extension of the limited radon surveying done to date in homes**, (d) **analysis for radionuclide contamination of wool and woven products** produced on site, and (e) a **near-field gamma survey.**

Navajo Bluewater site

General exposure assumptions

RME - Risk calculations were developed using the Reasonable Maximum Exposure (RME) approach outlined in the EPA *Risk Assessment Guidance for Superfund* (RAGS, 1989). The RME characteristically adopts the upper 95% confidence limit on the arithmetic mean of site data. 95% UCLs used in the exposure calculations are as follows:

External gamma - Brown Vanderver site:		425 µrem/hr
External gamma - Desiderio site:		197 µrem/hr
Soil radionuclides - Brown Vanderver site:	Ra-226	399 pCi/g
	U-233/4	330 pCi/g
	U-235	24 pCi/g
	U-238	367 pCi/g
Soil radionuclides - Desiderio site[1]:	Ra-226	34 pCi/g
	U-233/4	17 pCi/g
	U-235	0.7 pCi/g
	U-238	17 pCi/g

[1]Soil values for the Desiderio site represent the maximum detects rather than the 95% UCL, since the latter exceeded the sample maxima for all radionuclides.

External Gamma Exposures

Eqn: Gamma (mrem/hr)[a] x 10^{-3} rem/mrem x EF x ED x 6.2E-4 risk/rem[b] = risk

[a] 95% UCLs on readings at the B-V or D sites
EF = Exposure Frequency (hr/day x days/yr)
ED = Exposure Duration (years)
[b] Cancer incidence Ref: *EPA Risk Assessment Environmental Impact Statement NESHAPS For Radionuclides Background Information Document Vol. 1,* Table 6-7 (EPA 520/1-89/005)

External gamma exposure scenarios -

Sheepherder herding sheep on site:	EF = 4 hr/day x 300 d/yr ED = 2, 5 and 50 years
Child playing on site:	EF = 2 hr/day x 365 d/yr ED = 2 and 5 years

Comment - Exposure periods are based on time-use data provided by the Navajo Superfund Office (Window Rock, Navajo Nation, AZ) and reasonable maximum exposure assumptions regarding time spent in the vicinity of the tailings.

Navajo Bluewater site

Gamma Exposure Risks

	2 years	5 years	50 years
B-V Sheepherder	6E-4	2E-3	2E-2
B-V Child	4E-4	1E-3	na
D Sheepherder	3E-4	7E-4	7E-3
D Child	2E-4	4E-4	na

Note: Risks calculated for the <u>arithmetic mean</u> of external gamma radiation data from the Brown Vanderver and Desiderio sites (all site data combined) continue to exhibit risks in the 10^{-4} range for the 2-year exposure period.

Soil Ingestion Exposures

Eqn: C x IR x CF x EF x ED x SF = Risk

C - Concentration (pCi/g)
IR - Ingestion rate (mg soil/day)
CF - Conversion factor (10^{-3} g/mg soil)
EF - Exposure frequency (d/yr)
ED - Exposure duration (yrs)
SF - Ingestion slope factor (pCi^{-1})

Radionuclide	Slope Factor[1]
R-226 + Daughters	1.0E-9[a]
U-233/234	1.4E-10
U-235	1.3E-10
U-238	1.3E-10

[1]EPA Health Effects Assessment Summary Tables (1/91)
[a]EPA Risk Assessment Guidance for Superfund, Vol 1 Pt B (1991)

Soil ingestion exposure scenarios and assumptions:

Adult: 100 mg/day soil ingestion rate (RAGS, 1989)
365 d/yr exposure frequency
2, 5 and 70 year exposure duration

Child 200 mg/day soil ingestion rate (RAGS, 1989)
365 d/yr exposure frequency
2 and 5 year exposure duration

Navajo Bluewater site

Soil Ingestion Risks:

	Adult Risks			Child Risks	
B-V Site:	2-year	5-year	70-year[1]	2-year	5-year
Ra-226	3E-5	7E-5	1E-3	6E-5	1E-4
U-233/234	3E-6	8E-6	1E-4	7E-6	2E-5
U-235	2E-7	6E-7	8E-6	5E-7	1E-6
U-238	4E-6	9E-6	1E-4	7E-6	2E-5
Total	**4E-5**	**9E-5**	**1E-3**	**7E-5**	**1E-4**

[1] 70 year exposure assumes 65 years adult soil ingestion rate and 5 years child ingestion rate

	Adult Risks			Child Risks	
Des Site:	2-year	5-year	70-year[1]	2-year	5-year
Ra-226	2E-6	6E-6	9E-5	5E-6	1E-5
U-233/234	2E-7	4E-7	7E-6	3E-7	9E-7
U-235	7E-9	2E-8	2E-7	1E-8	3E-8
U-238	2E-7	4E-7	6E-6	3E-7	8E-7
Total	**2E-6**	**7E-6**	**1E-4**	**6E-6**	**1E-5**

[1] 70-year exposure assumes 65 years adult soil ingestion rate and 5 years child ingestion rate

Inhalation Risk Estimates - Radon Flux from Piles

The following risk estimates were provided by Barry Parks (EPA ORP, Las Vegas, NV.). Due to the uncertainties in estimating the source term, non-uniform distribution of the source term and limitations of the gaussian plume equation used in the CAP-88 software, risks are presented as **order-of-magnitude estimates** only. The risks are modeled for receptors present 100 meters from the center of the source (the nearest distance to the source which is appropriate for the gaussian plume model). Since residents at the site are frequently much closer to the piles than 50-100 meters, ambient air sampling for radon in the area of the mine wastes is recommended to more completely assess risks via this pathway.

Model Input:	Source area	10,000 square meters (source radius ~56 meters)
	Source term	100 Ci/yr
	Meteorological	Grants, NM weather data

Risk Summary

Receptor Location	2-year	70-year
100 meters SE*	**2E-4**	**8E-3**
100 meters NE	4E-5	1E-3

*Location of maximally exposed individual based on meteorological data

If you have question or comments regarding this memo I may be reached at FTS 484-2312 / (415) 744-2312.

cc: Terry Brubaker
Steve Dean
Yasmine Khonsary
Dick Lessler
Joanne Manygoats
Barry Parks
Colleen Petullo
Gaurav Rajen
Doug Steele
Don White
Tony Wolbarst

FAX TRANSMISSION

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	Organization: NAVAJO AREA I.H.S.		
	Mail Stop: P.O. BOX G HIGHWAY 264 WINDOW ROCK		
	FAX No.:	Area Code 8	Number 572 - 8296
	Verification No.:	Area Code 8	Number 572 - 8266
From	Name: Bill Weis U.S. Environmental Protection Region 9, Field Operations 75 Hawthorne Street San Francisco, California 94105		
	Division / Branch (mail stop): ERS. FOB.		
	Phone No.:	Area Code [redacted]	Number [redacted] 8-744-2297
	Fax No.:	Area Code 415	Number 744 - 1916 FTS 484 - 1916
Pages	(Including cover)		
Subject	EPA's RISK ASSESSMENT		
Note	FOR YOUR INFORMATION		

\Info-mgt\faxsheet.pm3 - revised 12/17/90 [1]

Cerrillos Land Company

6200 Uptown Blvd. N.E., Suite 400
Box 27019
Albuquerque, New Mexico 87125
505/881-3050

June 18, 1991

Mr. William J. Weis
Field Investigations and Enforcement
U.S. Environmental Protection Agency
75 Hawthorne Street
San Francisco, California 94105-3901

Subject: Bluewater Uranium Preliminary Assessment Data

Dear Mr. Weis:

Per our telephone conversation, I am enclosing the following material:

Attachment A:	Map of the Brown-Vandever uranium mine site.
Attachment B:	Mineral take-off of McKinley County court records for Section 13 T13N R11W, and Section 19 T13N R10W.
Attachment C:	Mineral leasing history for Section 13 T13N R11W, and Section 19 T13N R10W.
Attachment D:	Corporate chronology.
Attachment E:	Settlement documents in Santa Fe Pacific Railroad Company vs. Berryhill.

Additional information on royalty payments and production is being researched by Cerrillos Land Company.

Sincerely,

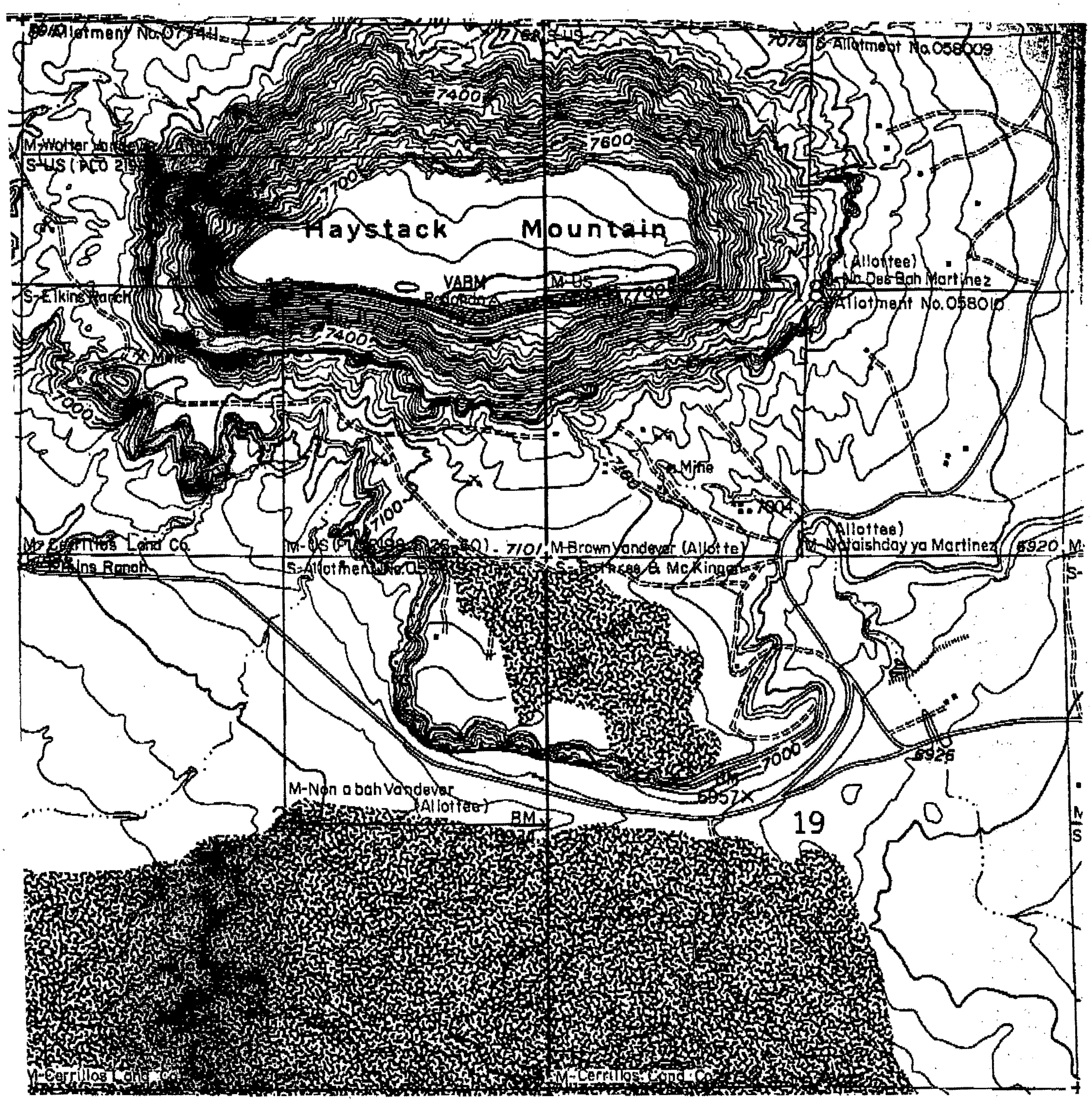
Tim Leftwich

Tim Leftwich
Director-Environmental Quality

TL:pt

Enclosures

HAYSTACK MTN. AREA



T 13 N, R 10 & 11 W

AMBROSIA LAKE HISTORY

SECTION 13, T.13N. R.11W.
SECTION 19, T.13N. R.10W.

Section 13, T.13N. R.11W. (SW/4)

1. First leased, September 30, 1952, from Santa Fe Pacific Railroad Company to Haystack Mountain Development Company (SFP-99989). Section leased until November 30, 1961. Haystack Mountain Development Company mined U_3O_8 during this period. Haystack Mountain Development Company was a subsidiary of The AT&SF Railway Company and was later merged into it.

2. On October 11, 1974, this property was leased to George Warnock (SFP-9945), for a period of 3 years. The lease was replaced by SFP-9961. Minimal exploration work occurred.

3. On October 11, 1975, the property was leased to Todilto Exploration and Development Corporation, (George Warnock's company, SFP-9961). There was production under the lease which terminated October 11, 1983.

   There has been no activity on the property since October, 1983.

Section 19, T.13N. R.10W. (All)

1. First leased, September 30, 1952, from Santa Fe Pacific Railroad Company to Haystack Mountain Development Company (SFP-99989). Section leased until November 30, 1961. Haystack Mountain Development Company mined U_3O_8 during this period. Haystack Mountain Development Company was a subsidiary of The AT&SF Railway Company and was later merged into it.

2. On December 1, 1961, SFPRR entered into a Contract for Construction and Other Work on Section 19 with Henri T. Dole. An identical contract has originally been entered into with Haystack Mountain Development Company on April 19, 1960. It was terminated as of December 1, 1961, and the new one signed (SFP-114492). This contract expired December 1, 1967. There was production of U_3O_8 during the term of this contract.

3. On April 15, 1975, Santa Fe Pacific Railroad Company entered into a Uranium Mining Lease and Agreement with George Warnock (later assigned to Warnock's company, Todilto Exploration and Development Company). Mining occurred through early 1981. The lease was terminated in February, 1985. The lease number was SFP-9950, and it covered only the N/2 NW/4 of Section 19.

AMBROSIA LAKE HISTORY

SECTIONS 23 AND 25, T.13N. R.10W.

Section 23, T.13N. R.10W.

1. First leased, September 30, 1952, from Santa Fe Pacific Railroad Company to Haystack Mountain Development Company (SFP-99989). Section leased until November 30, 1961. Haystack Mountain Development Company mined U_3O_8 during this period. Haystack Mountain Development Company was a subsidiary of The AT&SF Railway Company and was later merged into it.

2. Section 23 was included in the Contract for Construction and Other Work with Henri T. Dole from Santa Fe Pacific Railroad Company (SFP-114492). This was an identical contract, dated April 19, 1960, to one which Dole had with Haystack Mountain Development Company (HMD-27) which was terminated on December 1, 1961. This contract expired December 1, 1967. There was production of U_3O_8 during the term of the contract.

3. Section 23 was leased to United Nuclear Corporation, August 1, 1969 (SFP-9832). This contract terminated July 30, 1973. There was exploration under the lease, but the production appears to have come from Section 25 to the southwest, also under the lease.

4. Letter Agreement dated July 15, 1979, with Duane Berryhill, surface owner, agreeing Berryhill has the right to remove limestone for construction purposes subject to a royalty to SFPRR.

Section 25, T.13N. R.10W.

1. First leased, September 30, 1952, from Santa Fe Pacific Railroad Company to Haystack Mountain Development Company (SFP-99989). Section leased until November 30, 1961. Haystack Mountain Development Company mined U_3O_8 during this period. Haystack Mountain Development Company was a subsidiary of The AT&SF Railway Company and was later merged into it.

2. On December 1, 1961, SFPRR entered into a Contract for Construction and Other Work on Section 25 with Henri T. Dole (SFP-114492). This was identical to a contract Dole had with Haystack Mountain Development Company, dated April 19, 1960, which was terminated December 1, 1961. The contract expired December 1, 1967. There was production of U_3O_8 during the term of the contract.

3. On February 5, 1963, SFPRR leased 84.72 acres in the NE/4 of Section 25 to Farris Mines, which later assigned the lease to Smith Development Company. The lease expired February 5, 1971. There was production of U_3O_8 during the term of this contract (SFP-9713).

4. The rest of Section 25 was leased to United Nuclear, August 1, 1969 (SFP-9832) from Santa Fe Pacific Railroad Company. There was production from this section during the term which ended July 30, 1974.

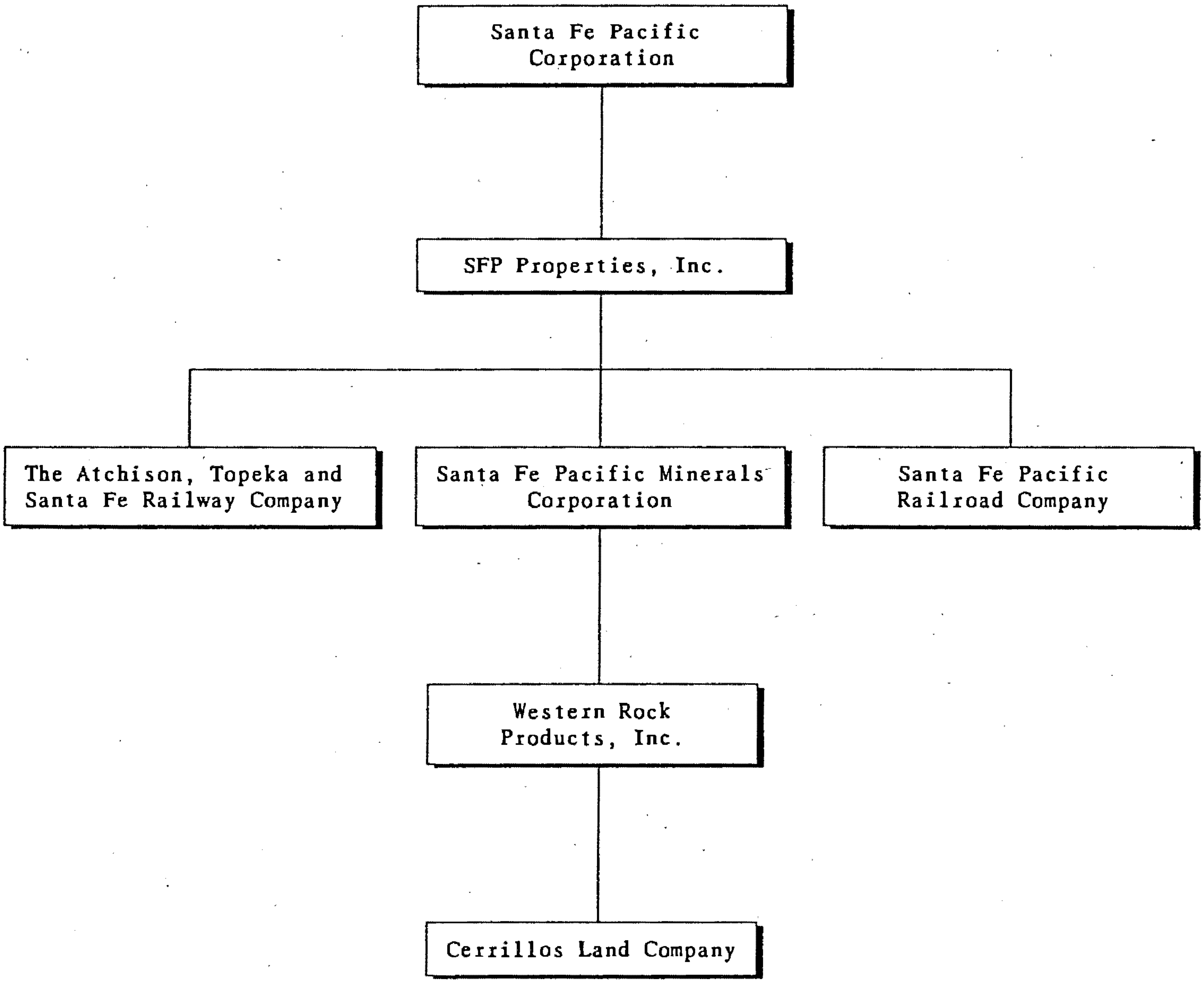
5. Petrodynamics, Inc., leased 82.84 acres in Section 25, from SFPRR on February 5, 1971 (previously leased under 3. above). This lease was quitclaimed back to SFPRR on February 4, 1974. The lease number is SFP-9882. It is not clear from the records whether this company did any work on the property.

6. Lease SFP-9934, dated February 5, 1974, was entered into between SFPRR and Citrus County Land Bureau, Inc., covering 82.84 acres in the NE/4 of Section 25 (the subject of leases in 3. and 5. above). This lease was assigned to WECO Development on April 1, 1976, and to Reserve Oil and Minerals Corporation on August 25, 1986. There was production under the lease, but it was from the Poison Canyon Mine in Section 19 in T.13N. R.9W.

CORPORATE CHRONOLOGY

Dec. 12, 1895	The Atchison, Topeka and Santa Fe Railway Company incorporated as Kansas corporation.
June 16, 1897	Santa Fe Pacific Railroad Company incorporated as Federal corporation; stock acquired by The Atchison, Topeka and Santa Fe Railway Company.
June 24, 1897	Santa Fe Pacific Railroad Company acquired properties of the Western Division of the Atlantic & Pacific Railroad Company.
Oct. 15, 1951	Haystack Mountain Development Company incorporated as Delaware corporation.
Dec. 4, 1967	Santa Fe Industries, Inc., incorporated as Delaware corporation.
Oct. 30, 1969	AT&SF, Inc., incorporated as Delaware corporation and subsidiary of Santa Fe Industries, Inc.
March 24, 1970	The Atchison, Topeka and Santa Fe Railway Company (Kansas) merged into AT&SF, Inc.; the survivor changed its name to The Atchison, Topeka and Santa Fe Railway Company (Delaware).
March 24, 1970	Santa Fe Industries, Inc., replaced The Atchison, Topeka and Santa Fe Railway Company as a NYSE listed and traded company.
June 5, 1978	Santa Fe Pacific Railroad Company stock transferred to Santa Fe Industries, Inc.
March 14, 1983	Santa Fe Pacific Minerals Corporation incorporated as Delaware corporation and subsidiary of Santa Fe Industries, Inc.
March 21, 1983	Cerrillos Land Company incorporated as Delaware corporation and subsidiary of Santa Fe Pacific Minerals Corporation.
Sept. 27, 1983	Santa Fe [Southern] Pacific Corporation incorporated as Delaware corporation.
Dec. 23, 1983	Santa Fe [Southern] Pacific Corporation became parent of Santa Fe Industries, Inc., and Southern Pacific Corporation.
April 27, 1987	Haystack Mountain Development Company merged into The Atchison, Topeka and Santa Fe Railway Company.
Sept. 1, 1987	Western Rock Products, Inc., stock transferred to Santa Fe Pacific Minerals Corporation.
Nov. 13, 1989	Santa Fe Industries, Inc., merged into SFP Properties, Inc., formerly Southern Pacific Corporation.
Dec. 18, 1989	Cerrillos Land Company stock transferred to Western Rock Products, Inc.

CURRENT PERTINENT STRUCTURE



Terry Brubaker	ERS-Chief	415-744-2293
Bill weis	ERS ENFORCEMENT	415-744-2297
RoberT BornsTein	ERS-Removal	415-744-2298
Robert Dorman	ORC-Law Clerk	" 744-1377
Linda Wandres	assistant Regional Counsel Office of Regional Counsel	" 744-1359
Tim Leftwich	Santa Fe Pacific MN.	505-880-5300

B. Ward

Section 19, T.13N.R.10W.Bluewater Quadrangle

Date	Owner	Operator
Dec. 1895 to June 1897	Atchison Topeka and Sant Fe RR Company	N/A
June 1897 to Sept. 1951	Santa Fe Pacific RR Company	N/A
Sept. 1951 to Nov 30. 1961	Santa Fe Pacific RR Company	Haystack Mountain Development Company
Dec. 1, 1961 to Dec. 1, 1967	Santa Fe Pacific RR Company	Henri T. Dole (Deceased)
Dec. 1, 1967 to April 14, 1975	Santa Fe Pacific RR Company	N/A
April 15, 1975 to Feb. 1985	Santa Fe Pacific RR Company	George Warnoc (Todilto Exploration and Development Co.)